



**6560-50-P**

**ENVIRONMENTAL PROTECTION AGENCY**

**[EPA-HQ-OAR-2002-0050; FRL-10006-13-OAR]**

**National Emission Standards for Hazardous Air Pollutants (Radionuclides),  
Availability of Updated Compliance Model, CAP88-PC**

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notice of Availability.

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**SUMMARY:** Pursuant to section 112 of the Clean Air Act, as amended, the Environmental Protection Agency (EPA or Agency) is announcing the availability of Version 4.1 of the CAP88-PC model. This version may be used to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) applicable to radionuclides. CAP88-PC is approved for this use by the EPA. Version 4.1 includes a number of improvements from previous versions, including Version 4.0. The most significant of these changes from a user perspective are the implementation of a new Wix installer technology that enhances compatibility with Windows 10 and future Windows updates, an update in the number of included radionuclides and the data for these radionuclides, and a change in the manner in which reports are printed.

**FOR FURTHER INFORMATION CONTACT:** Brian Littleton, Office of Radiation and Indoor Air, Radiation Protection Division (6608T), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW, Washington, DC 20460; telephone number: (202) 343-9200; fax number: (202) 343-2304;

email address: Littleton.brian@epa.gov.

## **SUPPLEMENTARY INFORMATION:**

### **I. General Information**

#### *A. Does this Action Apply to Me?*

You may be potentially affected by this action if you are subject to the requirements for radionuclide NESHAPs found in 40 CFR part 61, subpart H. This subpart applies to Department of Energy (DOE or Department) facilities.

#### *B. How Can I Get Copies of the Model and Other Related Information?*

*Docket.* The EPA has established a docket for this action under Docket ID No. **EPA-HQ-OAR-2019-0050**. Publicly available docket materials are available either electronically through [www.regulations.gov](http://www.regulations.gov) or in hard copy at the Air and Radiation Docket in the EPA Docket Center (EPA/DC), EPA West, Room B 102, 1301 Constitution Avenue, NW, Washington, DC. The EPA Docket Center Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air and Radiation Docket is (202)566-1742.

2. *Electronic Access.* You may access this **Federal Register** document electronically through the EPA website under the “Federal Register” listings at <http://www.epa.gov/fedrgstr/>.

3. *EPA Web Site.* You may download the CAP88-PC model and documentation from the EPA’s web site at <https://www.epa.gov/radiation/cap-88-pc>.

### **II. Background**

On December 15, 1989, the EPA promulgated the National Emission Standards for Hazardous Air Pollutants (NESHAPs) under section 112 of the Clean Air Act to control radionuclide emissions to the ambient air from a number of different source categories [54 FR 51654, December 15, 1989 (Docket EPA-HQ-OAR-2002-0050-0028)]. Subpart H of 40 CFR part 61 is one of the source categories covered in the 1989 final rule. Facilities owned and operated by the DOE are regulated under subpart H. The Department administers many facilities across the country, including government-owned, contractor-operated facilities. Some of these facilities handle significant amounts of radioactive material that could potentially be emitted into the air in various chemical and physical states. The purpose of subpart H is to limit radionuclide emissions (not including radon) from the stacks and vents at DOE facilities so that no member of the public receives an effective dose equivalent of more than 10 millirems per year (mrem/yr) or, in SI units, 0.1 millisievert per year (mSv/yr).

### **III. CAP88-PC Model for Demonstrating Compliance**

#### ***A. CAP88-PC History***

The EPA is today announcing the availability of Version 4.1 of the CAP88-PC model for use in demonstrating compliance with the requirements of 40 CFR part 61, subpart H. CAP88 (Clean Air Act Assessment Package-1988) is a set of computer programs, databases and associated utility programs for estimation of dose and risk from radionuclide emissions to the air. CAP88-PC implements, on the personal computer platform, modified versions of the AIRDOS-EPA and DARTAB codes that were written in FORTRAN 77 and executed in a mainframe

computing environment. CAP88-PC provides for dose and risk assessments of collective populations, maximally-exposed individuals and selected individuals. The original CAP88-PC software package, Version 1.0 allowed users to perform full-featured dose and risk assessments in a DOS environment for the purpose of demonstrating compliance with 40 CFR 61.93(a); it was approved for compliance demonstration in February 1992.

CAP88-PC Version 2.0 provided a framework for developing inputs to perform full-featured dose and risk assessments in a Windows environment for the purpose of demonstrating compliance with 40 CFR 61.93(a). Version 2.0 was approved for compliance demonstration in 1999. Version 2.1 included some additional changes compared to the DOS version and the previous Windows Version 2.0. The changes included the addition of more decay chains, improvements in the Windows code error handling and a modified nuclide data input form. The CAP88-PC User Guide provides a summary of the changes incorporated into Version 2.1 relative to Version 2.0.

CAP88-PC Version 3.0, released in 2006 (71 FR 8854, February 21, 2006), was a significant update to Version 2.1. Version 3 incorporated dose and risk factors from Federal Guidance Report 13, “Cancer Risk Coefficients for Environmental Exposure to Radionuclides” (FGR 13) in place of the RADRISK data that was used in previous versions. In addition, the CAP88-PC database, the user interface, input files and output files were modified to accommodate the FGR 13 data formats and nomenclature. Page 9 of the CAP88-PC Version 3 User’s Guide describes the modifications incorporated into Version 3 relative to Version

## 2.1.

CAP88-PC Version 4, released in 2015 (80 FR 7461, February 10, 2015), was a significant update to Version 3. While keeping the fundamental model unchanged, modifications were made to add flexibility, enhance stability of the code, and make it easier for the user to use while also improving the quality assurance of the modeling. The most significant of these changes from a user perspective were the incorporation of age-dependent radionuclide dose and risk factors for ingestion and inhalation (the use of which is specified by the user), the increase in the number of included radionuclides, and a change in the file management system used by the program. Those modifications produced a significant improvement in speed and stability for Version 4 relative to Version 3 and eliminated the solution approximations used in Version 3. The EPA also implemented an extensive testing and documentation program for CAP88-PC Version 4 to address user concerns with past versions. This enhanced documentation allowed for greater compatibility with user software quality assurance programs. The total number of nuclides available in Version 4 was increased from the 825 in Version 3 to 1,252. The maximum number of nuclides that can be included in any single case was increased from the 256 in Version 3 to 500 in Version 4.

CAP88-PC Version 4.1 incorporates the following changes to Version 4.0:

- 1) Dose and risk coefficient data have been updated to the values supplied by Oak Ridge National Laboratory with the Dose Coefficient Data File Package (DCFPAK) Version 3.02 (addition of internal dose information for 151 isotopes;

updated information for isotopes in vapor or gas forms; and additional risk information for many isotopes);

- 2) The ability to print from the Reports tab has been removed because of incompatibility of certain characters in the reports with some printer drivers. Printing reports can be done by opening the report files in any word processor or text editor. The new button opens the location of the report files;
- 3) The synopsis file now provides the adjusted fractions of milk, meat, and/or vegetables produced in the assessment area, if CAP88-PC adjusted them to account for population;
- 4) Enhancements to the user interface code have been made to increase performance and/or maintain compatibility with the DCFPAK Version 3 data;
- 5) The installer system has been updated for better compatibility with Windows;
- 6) Migration utility updates have been made to migrate data from Version 3 to Version 4.1 formats; and
- 7) The user interface has been updated to provide automatic conversion of Version 4.0 datasets to Version 4.1.

In summary, Version 4.1 enhances and completes the updates initiated under CAP88-PC Version 4.0 and incorporates compatibility for newer operating systems.

#### *B. CAP88-PC Model Summary*

All versions of CAP88-PC use a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six sources.

The sources may be either elevated stacks, such as a smokestack, or uniform area sources, such as a pile of uranium mill tailings. “Plume rise” can be calculated assuming either a momentum or buoyant-driven plume. Assessments are made for a circular grid of distances and directions for a radius of up to 80 kilometers (50 miles) around the source. The Gaussian plume model produces results that agree with experimental data as well as any model, is fairly easy to work with and is consistent with the random nature of turbulence. Site-specific information on population location and meteorological conditions is provided to CAP88-PC as input files developed by the user. The formats for these input files have not changed from the original mainframe version of the CAP88 code package.

CAP88-PC Version 4.1 is a modification intended to improve usability, enhance the modeling methodology, update the dataset formats, and provide a more maintainable code base and documentation set for the future. Version 4.1 provides age-dependent dose conversion factors and lifetime risk factors and uses a code architecture that conforms to more recent coding standards and data formats. The data updates include adoption of the ingestion and inhalation age and particle size dependent dose and risk factor data supplied by Oak Ridge National Laboratory in the DCFPAK Version 3.02 model<sup>1</sup>, and age-dependent ingestion and inhalation rates from the EPA.

The CAP88-PC Version 4.1 software was developed using a structured software engineering methodology that included adoption of a defined software architecture, rigorous source control, independent verification of source code as it was being implemented, multiple phases of testing, and configuration control of

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<sup>1</sup> <https://www.epa.gov/radiation/tools-calculating-radiation-dose-and-risk>

the documentation and the code as development progressed.

To conform to Windows 10 security requirements, and to improve usability, case-specific input and output data files are now stored by default in the user's Windows profile folders, rather than in the application's Program Files folder.

CAP88-PC Version 4.1 input datasets can be stored in their own folders, as subfolders of the Datasets folder. As an example, for the Modtest dataset included with the Version 4.1 distribution set, the folder holding the dataset and all associated data files and reports would be located at

c:\Users\xxxx\Documents\CAP88\Datasets\Modtest. Datasets are recommended to be put into their own folders, because using this data storage structure will simplify use of the code and management of case data. Reports are always stored in the same folder as the dataset. Population and wind files can be stored with the dataset or in the default Population/Wind folders. However, CAP88-PC Version 4.1 will preferentially use the population and wind files located in the dataset.

This improves sharing of dataset information between organizations and simplifies configuration management of cases because all pertinent case records (input and report files) are stored together. A user can send a dataset, its population and wind files, and its reports to another user, who can open them, using CAP88-PC Version 4.1 or any text editor, confident that the proper files are being used.

As was the case with Versions 3 and 4.0, Version 4.1 is not backward compatible, and datasets generated using Versions 3 and 4.0 cannot be used directly by Version 4.1. This is the result of many factors, including the addition



of age-specific data and the inclusion of many more nuclides than in previous versions. However, both Versions 4.0 and 4.1 include a dataset migration utility that upgrades many Version 3 datasets to the applicable Version 4.0 or 4.1 format. The migration utility runs on first use and is also available on demand from the Tools>Options drop-down menu. The migration utility will move Version 3 database files, input dataset files, population files, and wind files from the format used with the 9 December 2007 release of Version 3 to their respective Version 4 formats. The folder locations of the Version 3 files being migrated and the locations for the Version 4 files being generated are selectable by the user or the utility will select the default locations for those files.

The overall principle of the Version 4 architecture was to optimize the code by performing data manipulation in the user interface and computational functions in FORTRAN. CAP88-PC Versions 4.0 and 4.1 have accomplished this by having the user interface collect the user input data, read the associated databases, generate the dose and risk factors from the DCFPAK data, then build and write the case dataset. The user interface also handles all program interactions with the file system. The FORTRAN computational sub-system now performs all decay and ground surface buildup calculations along with all the air dispersion, deposition, intake, dose, and risk calculations. The only file manipulation performed by the FORTRAN sub-system is reading the dataset files and writing report files. The data system used in CAP88-PC Version 4.1 has access to information for all 1,252 radionuclides, including those for which internal dose and risk factors have been added in to DCFPAK Version 3.02.

### *C. Validation of the CAP88-PC Version 4.1 Model*

The CAP88-PC Version 4.1 program is a well-established and validated code for the purpose of making comprehensive dose and risk assessments. The Gaussian plume model used in CAP88-PC to estimate dispersion in air is one of the most commonly used models for dispersion modeling. It produces results that agree with experimental data as well as any model, is fairly easy to work with, and is consistent with the random nature of turbulence. Version 4.1 has not modified the basic Gaussian plume algorithm used by the AIRDOS module of CAP88-PC, and comparison cases between Versions 4.0 and 4.1 have been run.

The EPA's Office of Radiation and Indoor Air (ORIA) has reviewed the testing report submitted by the contractor and verified the results through independent testing. The report can be found at <https://www.epa.gov/radiation/cap-88-pc>.

As part of the software testing, the user interface was extensively tested. The testing verified that the interface only accepted:

- 1) Positive distances less than or equal to 80 kilometers (km) for receptor distances;
- 2) Non-negative release rates;
- 3) Annual precipitation amounts between 0.01 and 500 centimeters per year (cm/yr);
- 4) Annual ambient temperatures between -100 and 100 degrees Celsius (°C);

- 5) Lid heights between 25 and 10,000 meters (m);
- 6) Non-negative source heights, and positive source diameters or areas;
- 7) Non-negative heat release rates, exit velocities and fixed plume rises; and
- 8) Agricultural fractions that summed to unity.

All issues identified with the interface have been resolved and closed. Seven test cases were developed to test the capabilities of CAP88-PC Version 4.1. Six of these cases involve the calculation of dose and risk to an individual or population at the location identified by the model as that of the maximally exposed individual (MEI) or specified by the user. The testing objectives for these six cases include the following verifications:

- 1) Dose factors agree with those calculated using the DCFPAK 3.02 from Oak Ridge National Laboratory to 1% or less;
- 2) Values of Chi-over-Q ( $\chi/Q$ ) agree within 1% with those calculated using CAP88-PC Version 4.0, including but not limited to the direction of the MEI (the calculated values for  $\chi/Q$  showed good agreement between Versions 4.0 and 4.1 in all directions);
- 3) Air concentrations and deposition rates (where applicable) agree within 1% with those calculated using CAP88-PC Version 4.0; and
- 4) Results for dose rates and risks agree within 5% of independent calculations; the 5% criterion was used here to allow for differences caused by different

modeling methods.

The objective of Test Case 7 was to verify the CAP88-PC Version 4.1 calculations of the air concentrations and working levels for radon-only are consistent with Version 4.0.

#### *D. Limitations of the CAP88-PC Model*

Like all models, there are some limitations in the CAP88-PC system. While up to six stacks or six area sources can be modeled, all the sources are modeled as if located at the same point; that is, stacks cannot be located in different areas of a facility. The same plume rise mechanism (buoyant or momentum) is used for each source. Also, area sources are treated as uniform. Variation in radionuclide concentrations due to complex terrain cannot be modeled. Errors arising from these assumptions will have a negligible effect for assessments where the distance of exposed individuals is large compared to the stack height, area or facility emissions.

#### *E. Use of CAP88-PC Version 4.1 for Compliance Purposes*

In the same manner as CAP88-PC Version 4.0, Version 4.1 allows the user to incorporate the age-specific dose conversion factors and intake rates contained in DCFPAK Version 3.02. The code allows the user to select the ingestion and inhalation dose conversion and intake rates from the age groups modeled in DCFPAK Version 3.02: infant (100 days old), one-year old, five-year old, ten-year old, fifteen-year old, and adult. However, the addition of this capability does

not change the requirements for compliance to the NESHAPS Subpart H requirements. These are clearly stated in 40 CFR part 61 Subpart H. The ability to allow the code base to include age-dependency does not impact or imply changes to the compliance demonstration.

*F. Summary of Changes for CAP88-PC Version 4 to Version 4.1.*

Version 4.1 of CAP88-PC is an update from Version 4.0, and a significant upgrade from earlier versions. CAP88-PC Versions 4.0 and 4.1 not only added significant features, but also redesigned the interface to give the user a more standard experience. The entire user interface module was re-written for Version 4 using VB.Net, the Microsoft.Net Framework Version 4, and the Visual Studio 2010 development environment, in order to better comply with updated code standards in Windows 7, Windows 8.1. and Windows 10. Specific changes from Version 4.0 visible to the user in Version 4.1 include:

*User Interface*

- 1) The Print button on the Reports tab has been replaced with a button that opens the folder holding the report files which may then be printed using a word processing program;
- 2) Some labels in the user interface have been modified for clarity;
- 3) The capabilities for migrating datasets from previous versions of CAP88-PC have been improved, including automatic conversion of Version 4.0 datasets to Version 4.1.

*Reports*

- 1) Some report headers have been modified for clarity;
- 2) The Agricultural Data in the Synopsis report now prints the values for the fractions of vegetables, milk, and meat from the assessment area used in the calculation, which may have been adjusted by CAP88-PC from the input values.

#### *Data*

- 1) The dose and risk coefficients have been updated from DCFPAK 2.2 to those in DCFPAK 3.02 provided by Oak Ridge National Laboratory;
- 2) Internal dose and risk coefficient factors for 151 more radionuclides have been added;
- 3) Additional risk coefficient data has been added for more radionuclides and chemical forms beyond the additional 151;
- 4) Inhalation coefficients for radionuclides with special chemical forms, such as iodine, have been added.

#### *Error Handling*

CAP88-PC Versions 4.0 and 4.1 contain an internal error logging and tracking system. In the case of internal code errors, the code will write errors to a file in the Message Log folder located in the same folder set as the folder containing the datasets. Sending this file to the EPA representative will facilitate troubleshooting.

#### *On-Line Help System*

CAP88-PC Version 4.1 includes a context-sensitive help system that is accessible during operation. The on-line help system is a hypertext version of the traditional user manual; the traditional user manual is included as part of the release distribution package in pdf format.

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**Lee Ann B. Veal,**

*Director, Radiation Protection Division,*

*Office of Radiation and Indoor Air.*

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